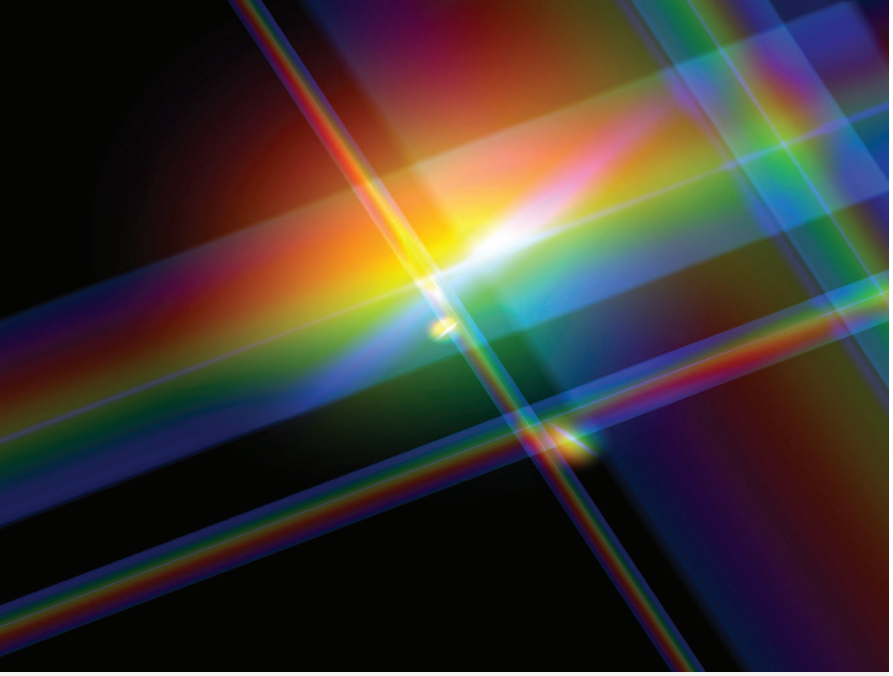

National Aeronautics and Space Administration

Optics

Micro-Ring Thin-Film Spectrometer Array

Miniaturized system for rapid multi-spectral analysis and imaging

NASA's Langley Research Center researchers have developed a novel spectral analysis system that provides rapid multispectral analysis and imaging, in a miniaturized system design. Typical spectrometers make use of linear gratings with linear slits or charge-coupled device (CCD) arrays to separate and detect light in its component wavelengths to build a spectrum across a range of wavelengths. Such conventional spectrometers are difficult to miniaturize below a few centimeters. Creating an image with these systems also requires physical rastering of the light beam and detection system across an area to build up the individual data points of an image. The NASA Micro-Ring Thin-Film Spectrometer technology makes use of a micro-ring grating to separate the component wavelengths of the light signal for detection and spectral analysis. Due to the miniaturized design obtained by Fresnel diffraction, an array of these micro-ring grating-based spectrometers can be constructed to enable extremely small-size multi-spectral imaging of an analysis area.

BENEFITS

- Miniaturized spectrometer design (volume of optical path between grating and detector can be as small as 1 mm3 and diameter can be 0.75mm)
- Multiple options available for designing the micro-ring grating and the wavelength focusing/detection system. Allows for flexibility and optimization of the design for different applications
- The miniaturized spectrometer design can be used to build a microring grating array for a miniaturized spectrometer array that provides moderate resolution and rapid multi-spectral imaging
- The miniaturized spectrometer design can be used to build densely integrated spectral scanners for thousands of optical fibers

technology solution

THE TECHNOLOGY

The NASA Micro-Ring Spectrometer technology is based on a micro-ring grating consisting of a series of concentric rings created in a thin-film structure of micron dimensions. The rings alternate between opaque and transparent and cause the light beam to diffract into a continuum of focal points as a function of wavelength along the axis of the light beam itself. Thus, by detecting and scanning along the axis, different wavelengths of light can be detected to create the spectral response. Alternatively, by using an electro-optic layer that changes refractive index as a function of applied voltage, various wavelengths can be selectively focused at a fixed focal point into an aperture slit. No additional lenses or mirrors are necessary since the micro-ring grating serves to focus the light at the same time as dispersing it into its component wavelengths on the optical axis. The small size of the micro-ring gratings and the simplistic design allow for extreme miniaturization of the spectrometer or spectrometer array.

The NASA technology has many potential medical applications.

APPLICATIONS

The technology has several potential applications:

- Micro-optical spectral analysis and imaging for:

  -- Semiconductors
  -- Medical applications
  -- Materials analysis
  -- Remote spectral analysis
  -- Implanted or embedded spectral analysis

PUBLICATIONS

Patent No: 8,174,695; 8,094,306; 8,059,273

More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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